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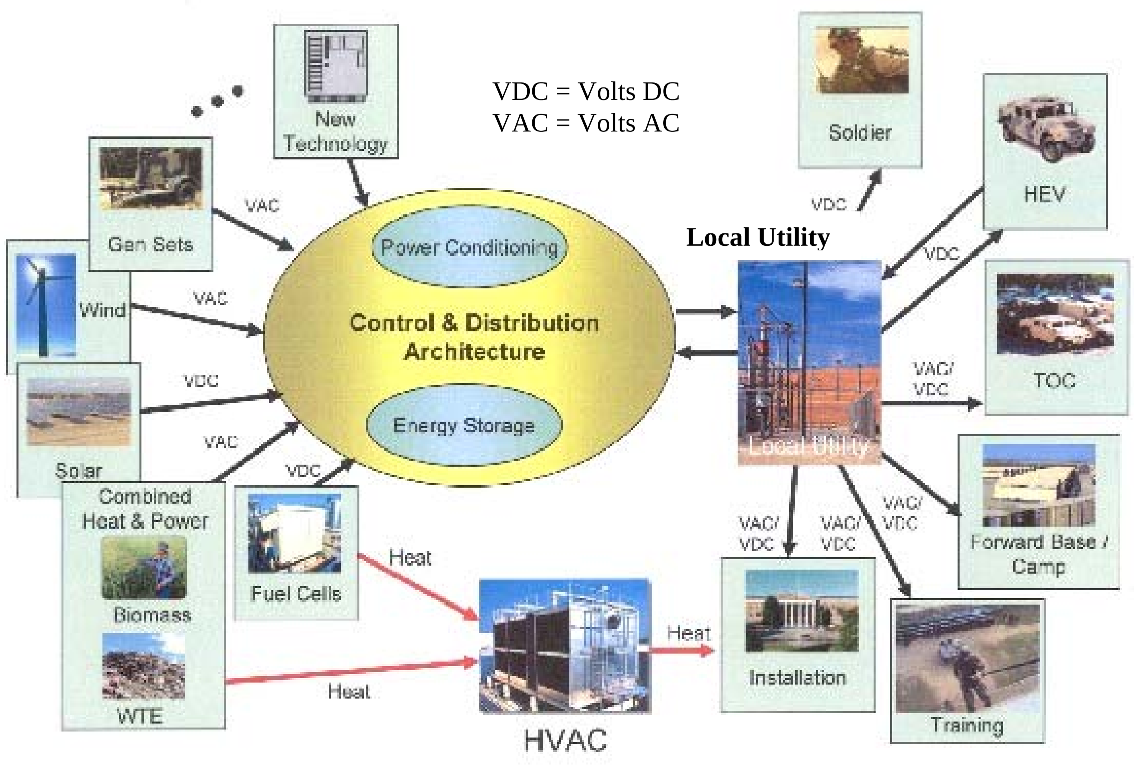
Proceedings of the 1st Army Installation Energy Security and Independence Conference

Thomas J. Hartranft, Frank Yeboah, Dennis Grady,
and Roch Ducey

March 2007



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Proceedings of the 1st Army Installation Energy Security and Independence Conference

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Final Report

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Abstract: This report is about energy security ... for mission accomplishment. Is energy security assured by backup generator sets dedicated to individual buildings that are pre-identified as critical assets – with fuel for 3-5 days? Suppose a utility power grid outage occurs. Today it is impossible to locally wheel power from dispersed individual onsite fossil-fueled or renewable power sources to facilities or other power loads ... anywhere at any time. Each power source is stranded; powering only one load. Relocating generator sets and engineering their electrical connections to other power loads are not speedy or trivial tasks. There are many mission aspects that go unpowered in a blackout because Army cannot afford backup generator sets for every building, training range, sewer treatment plant, warehouse, motor pool, etc. Even if everything has dedicated backup generators, experience shows that 50 percent will not operate right anyway ... and they will run out of gas after 3-5 days. Mission priorities are dynamic; power outages are unpredictable. Commanders must have the ability to wheel dispersed and finite on-installation power anywhere at anytime and to allocate stored fuels for extended outages. A new vision of energy security is needed for the asymmetrical threats and dynamics of the GWOT era.

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Preface

The energy security and independence conference and this technical report were accomplished as an independent CERL-funded initiative conducted for the benefit of Army installations and policy leaders. The technical monitor was Dr. Thomas Hartranft.

The report was accomplished by the Energy Branch (CF-E) of the Facilities Division (CF), U.S. Army Construction Engineering Research Laboratory (CERL) with writing inputs from North Carolina A&T University, and Appalachian State University. The CERL Principal Investigators were Dr. Thomas Hartranft and Roch Ducey. Principal Investigator from North Carolina A&T University was Dr. Frank Yeboah and from Appalachian State University was Dr. Dennis Grady. The authors want to acknowledge the contributions of Dr. Harmohindar Singh of North Carolina A&T University for hosting and facilitating the Army Energy Security and Independence conference. The authors also acknowledge the contributions of all presenters and other participants at the conference. Martin J. Savoie is the Technical Director for the Installations business area. Dr. Thomas Hartranft is Chief, CF-E, and L. Michael Golish is Chief, CF. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Richard B. Jenkins, and the Director of ERDC is Dr. James R. Houston.

1 Introduction

1.1 Background

Army installations are essential for the development and sustainment of operational capabilities and readiness to serve and protect the nation and its interests. Installations are small cities with a full spectrum of facility types and utility requirements that use large amounts of energy. Army Engineering Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) Energy Branch studied energy trends and their implications for Army installations (Fournier and Westervelt 2005) and also studied and published a candidate Army Energy Strategy for installations (Fournier and Westervelt 2004). The Army Assistant Chief of Staff for Installation Management (ACSIM) subsequently published Army's Energy and Water Management Strategy for Installations (HQDA 2005) based in part on these ERDC-CERL Energy Branch studies and analyses (Fournier and Westervelt 2004, 2005). The Army Strategy has five objectives:

- To eliminate energy waste in existing facilities
- To increase energy efficiency in renovation and new construction
- To reduce dependence on fossil fuels
- To conserve water resources
- To improve energy security.

Army subsequently published a 2006 Energy Campaign Plan documenting implementation tasks to achieve these five objectives (HQDA 2006). The Army Installation Energy Campaign Plan is quite extensive on demand-side energy efficiencies, which in turn are focused on power and energy affordability and reduced use of fossil fuels. However, the Plan has limited guidance on installation energy security.

Energy Security initiatives should address what constitutes energy security in warfighting mission metrics for Power Projection and Force Readiness. What percent of the normal installation power is necessary to deploy troops for Power Projection? 10%? 20%? 50% or more? How long must this minimum power level be sustained? 5 days? 30 days? 6 months? Such metrics enable decisionmakers to identify material versus Doctrine, Op-

erations, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF)-related functional analyses. If such analyses lead to material solution needs, then these metrics also become the basis for research or engineering solution investments by the Army.

1.2 Objectives

Consensus is needed on a future requirements-based "vision" for energy security to enable leaders to identify capability gaps suited to engineering solutions, new procedures, or new research needs. This in turn enables installation policy leaders to establish a defensible energy security infrastructure budget to fund the needed activities leveraged with other U.S. energy investments. Thus a primary objective of this conference was to begin to translate this top-level energy security objective into military mission performance metrics that facilitate expanded investment decision-making using the established material versus DOTMLPF functional analysis methodology used for weapon systems.

1.3 Approach

The ERDC-CERL Energy Branch planned, coordinated, and led this Army Installation Energy Security and Independence Conference. It was held 12-13 December 2006 on the campus of ERDC Educational Partner North Carolina A&T State University in Greensboro, NC. The nearly 100 participants were from: Assistant Chief of Staff for Installation Management; Installation Management Command; ERDC; Research, Development, and Engineering Command; Fort Bragg NC; Fort Jackson SC; Fort Sill OK; Department of Energy; academia; state energy programs; energy service organizations; and the utility industry. Table 1 lists conference presenters and their presentations. The Appendix to this report contains links to all conference presentations.

1.4 Mode of Technology Transfer

This report will be made accessible through the World Wide Web (WWW) at URL:

http://www.cecer.army.mil

Table 1. Conference presenters and their presentations.

Time	Invited Speaker/Organization	Confirmed Speakers/Participants
Day 1	*12 December 2006*	
08:00-08:30	Registration	
08:30-08:45	Welcome	Dr. L. Hackley Chancellor A & T
Session I Army energy security for installations - What are the current policies for energy security/independence? What are the issues facing Army installations? Moderator: Jim Paton		
08:45-09:30	Sustain the Mission - Secure the Future	Richard O. Murphy, Dept. of the Army HQ, Assistant for Sustainability
9:30-10:00	Impact of Energy Infrastructure Disruptions on Army Operations	Joe Dickman, Dept of Army
Fit Jim into this slot	ACSIM	Jim Paton, ACSIM Energy Security Mgr.
10:00-10:30	IMCOM	Paul Volkman, IMCOM Energy and Utilities Mgr.
10:30-10:45	Break	
10:45-11:15	Fort Bragg Speaker	COL Gregory G. Bean, Director of Public Works, Fort Bragg, NC
11:15-12:00	Panel Discussions	Jim Paton
12:00-13:30	Working Lunch Speaker- Draft of invitation letter from Larry to Tony Rand was sent to Larry	Larry Shirley, Director NC State Energy office
Session II What are the future visions for Army installation energy security and independence? Moderator: Roch Ducey		
13:30-13:55	Energy Surety Microgrids for Military Applications	Dr. Abbas Akhil, Sandia National Laboratories
13:55-14:20	Army Energy Security: A Vision for the Future	Dr. Thomas Hartranft, Energy Branch Chief, ERDC-CERL
14:20-14:45	TARDEC/NAC Speaker	Harold Sanborn, TARDEC National Automotive Center
14:45-15:00	Break	
15:00-15:25	Emergency Preparedness and Disaster Recovery	Prof. John Pine, title? organization?
15:25-15:50	Economic Diversification of Energy Sources	William (Bill) Stein
15:50-16:30	Panel Discussions	Roch Ducey
16:30-17:00	Wrap-up and Take-away Summary	Steve Kalland

Time	Invited Speaker/Organization	Confirmed Speakers/Participants
Day 2	*13 December 2006*	
08:30-08:45	Take-away Summary of Day 1 Discussions	Steve Kalland
Session III *Grid reliability and distributed power generation delivery* *Moderator: Keith McAllister*		
08:45-09:15	Duke Power Speaker	Ms. Marilyn Lineberger
09:15-09:45	DOE Speaker	Ms. Merrill Smith
09:45-10:15	Applications of Distributed Energy Technologies	Paul Bautista
10:15-10:30	Break	
10:30-11:00	Speaker from Sandhills Utilities	Jeff Brown COO/Jon Parsons
11:00-11:30	Microgrid on distribution Scale	Dr. Bob Lasseter
11:30-12:00	Panel Discussions	Keith McAllister
12:00-13:00	DOD Security Trends for Clean Energy	1. Scott Sklar, President, The Stella Group, Ltd. 2. Steve Siegel VP, Energy and Security Group
Session IV *Emerging energy, distribution, and storage technologies that contribute to energy security/independence* *Moderator: Dr. Dennis Grady*		
13:00-13:25	Emerging Technologies-University of South Florida	Dr. Yogi Goswami
13:25-13:50	Renewable and Bio-Energy-NC State University	Dr. Alex Hobbs
13:50-14:15	The Lignocelluloses Bio-Refinery - Reality, hype or Something in Between-NCSU	Dr. Steve Kelley
14:15-14:30	Break	
14:30-14:55	Integrated Energy Systems	Robert C. DeVault
14:55-15:20	Energy Storage- Sandia Labs	Mr. John Boyes
15:20-15:45	Tactical Power Microgrids	Dr. Darrell Massie
15:45-16:25	Panel Discussions	Dr. Dennis Grady
16:25-17:00	Wrap-up and Take-away Summary	Dr. Dennis Grady

2 Energy Security Policy for Installations

Current thinking is to have dedicated back up generator sets for facilities pre-identified as critical to mission accomplishment. Consequently, there is a perception that energy security is assured by backup generator sets dedicated to individual buildings that, in turn, are pre-identified as critical assets. This approach has several operational shortcomings:

- Today's non-critical facilities could unexpectedly become critical facilities on short notice as installation Power Projection and Force Readiness missions quickly adapt to changes in relation to the Global War on Terror (GWOT). Thus, the dedicated generator set approach is not responsive to GWOT asymmetries or dynamics since moving generator sets and engineering their electrical connections to buildings are not speedy or trivial tasks. Today there is no means for mission commanders to wheel power from these generator sets to any other mission power needs … for an hour, for 6 hours, for several days. Hence the power of these costly power delivery units are stranded – locked to single buildings that a planner years ago identified as a critical asset for an as yet unknown emergency mission need years in the future. Are our crystal balls that good?
- The capital investment of dedicated generator sets is a "stranded" investment that does not benefit 24/7 installation operations. The generator sets are generally only used in emergency situations. They are sometimes employed for Peak Power Shaving, but only through elementary control schemes for limited building loads. Also, environmental laws restrict total yearly operating hours due to fossil fuel emissions from the diesel generator sets.
- There is an uncertain likelihood of proper operation of the generator sets when an emergency power need arises. The 2003 blackout in the northeast United States and the 2005 Gulf Coast hurricanes showed numerous cases where such dedicated backup generator sets did not operate or operated for only a short time before stopping. DOE presented graphic data in the conference of the extent of generator sets that did not operate in these emergency situations.
- DoD aspires to increase penetration of renewable power sources like solar and wind up to 25 percent of all installation power by 2025. Seamlessly blending onsite renewables with fossil-fueled generators

> would extend power delivery duration during extended utility grid outages. But how will intermittent renewable power sources be optimized for 24/7 operation and be employed to power any facility need during times of power grid outage? There is no means today to wheel such power anywhere at any time. Such renewable power is less than total installation demand, is not available 24/7, and is subject to installation grid and facility power interface stability issues. But it does not need to be so.

Why should emergency installation mission accomplishment be limited by stranded power delivery and energy storage? Why not aspire to an installation power control and distribution architecture that can wheel onsite power and energy anywhere on the installation at any time ... at the discretion of mission commanders? This then sets the stage for why this conference is so important to DoD installations.

3 Conference Presentation and Discussion Summaries

The agenda addresses four topics relevant to Army Energy Security:

1. Army Energy Security for Installations (What Are the Current Policies for Energy Security and Independence? What Are the Issues Facing Army Installations?)
2. Future Visions for Army Installation Energy Security and Independence
3. Grid Reliability and distributed Power Generation Delivery
4. Emerging Energy, Distribution, and Storage Technologies that Contribute to Energy Security and Independence.

A synopsis follows for each of the four conference topics. These are brief narratives or summary listings of conference highlights to help readers quickly grasp key take-away insights. Each presentation is contained in its entirety in the Appendix to this report.

3.1 Army Energy Security for Installations – What Are the Current Policies for Energy Security and Independence? What Are the Issues Facing Army Installations? (Day 1, Sub Session I)

The following highlights are provided for presentations and discussions of sub session I.

3.1.1 Army Energy Security Policy

Mr. Paton presented an overview of Army Energy Security Policy requirements as follows:

- Institute energy security concepts and methodologies in Army installation management operations:
  - Develop energy security survey methodology
  - Develop standards for utility system and energy supply reliability
  - Develop facilities prioritization methodology
  - Update installation energy security plans and water vulnerability assessment and response plans

  - Develop economic impact methodology for various energy interruption scenarios
- Implement energy security plans and continuously improve the Army Energy Security Program:
  - Command level review of plans for quality and completeness
  - Estimate costs, submit requirements into budget, and execute energy security projects
  - Incorporate energy security considerations into the design process
  - Conduct annual review of energy security program
  - Incorporate energy security rating into Installation Status Report
- Use current and projected energy sources with greatest potential for availability and economy:
  - Participate with other Defense and Federal agencies and academia in forums to assess energy supply trends in order to use technologies using abundant energy sources
  - Partner with DOE and other Services to develop a facility energy source evaluation and execution strategy to allow continuous application of the most secure and reliable energy source at each facility
  - Establish process to survey, test, evaluate and implement technologies.

3.1.2 Installation Management Command Energy Security

Mr. Volkman highlighted the series of energy security policies put out by DoD and Army for the past 25 years:

- Defense Energy Program Policy Memorandum (DEPPM) 86-2 (1986)
- DEPPM 88-3 (1988)
- Army Energy Security Program Assessment Guide and Plan (1990)
- DEPPM 92-1 (1992)
- DoD Energy Manager's Handbook (1996)
- Army Regulation (AR) 11-27 (1997).

The heart of these security guidance policy memorandums is for installations to accomplish energy security plans that have the following main objectives (Extracted from Dr. Massie's presentation in Sub Session IV):

- Assess on-post energy vulnerability (storage, distribution and supply systems)
- Assess off-post energy vulnerability (commercial energy supplies)
- Assess the consequences of energy disruptions

- Make an integrated analysis and write a report
- Validate conclusions on energy vulnerability
- Implement corrective measures.

3.1.3 DoD Critical Infrastructure Risk Management

Mr. Dickman's morning presentation of DoD's Critical Infrastructure Risk Management (CIRM) program identified the following good DoD initiatives for Army to leverage:

- Critical infrastructure risk analysis center
- Planning for inclusion in formal training
- Conducting outreach program
- Identifying defense critical assets
- Embedded critical infrastructure risk management program staff at field commands
- Writing program policy documents
- Conducting commercial network disruptive analysis.

The conference participants thought of other candidate next steps:

- ACSIM and IMCOM engage with CIRM to seek common policy and support to installation vulnerability assessments
- CIRM program office should seek technical counsel from DoD and DOE labs
- CERL invite CIRM to Fort Sill FY07 security demo

3.1.4 General Sub Session I Security Requirements Discussions

The following articulates participants' considerations for refining Army energy security requirements as a result of the session presentations and discussions:

- Army energy security and independence performance requirements
- ACSIM views Army Energy Campaign Plan security tasks as being in need of refinement and expansion. In addition to previous topics for inclusion, appears to be a need to establish task(s) to
    - Establish and document Army requirements for power and energy delivery through mission decomposition, field demos, capability gap analyses, etc.
    - Update vulnerability analyses based on refined requirements to include Power Quality

  - o Identify and prioritize Army-urgent technoligies to develop
  - o Blend renewables + storage into 24/7 power delivery mix
  - o Actively partner with CIRM, DOE, Army Labs, EPRI, etc. to influence technology transition for Army requirements

3.1.5 Sub Session I Consensus Observations and "Next Steps"

The following collection of vulnerability analysis observations and next steps are summarized to ensure they are addressed in ongoing policy and execution actions:

- Make FEMP model security assessment template and lessons learned available via online inclusion in Army Campaign Plan website, etc.
- Army Campaign Plan tasks call for central data collection and analysis. There are some funds budgeted by Army to do this.
- Clarify government energy security requirements for utilities privatization contractors
- Evaluate vulnerability assessment guidance for Power Quality
- Need to stabilize BRAC, etc. force basing changes … still unclear
- Candidate funding sources for energy security requirements:
  - o Review existing installation vulnerability assessment plans for energy security-related needs and associated cost estimates to get a handle on total costs and common installation needs for possible bundling of funding for selected systemic Army shortcomings.
  - o Consider leveraging off of IMCOM initiative for Utilities Modernization of non-privatized utilities.
  - o CIRM central Army program. Perhaps fund outside-the-gate needs to provide an installation buffer with surrounding civilian community.
  - o Connect ECIP or ESCO projects to energy security for preferential HHQ consideration.

3.2 What Are the Future Visions for Army Installation Energy Security and Independence? (Day 1, Sub Session II)

The first three session presentations spoke of microgrid power architecture as illustrated in Figure 1.

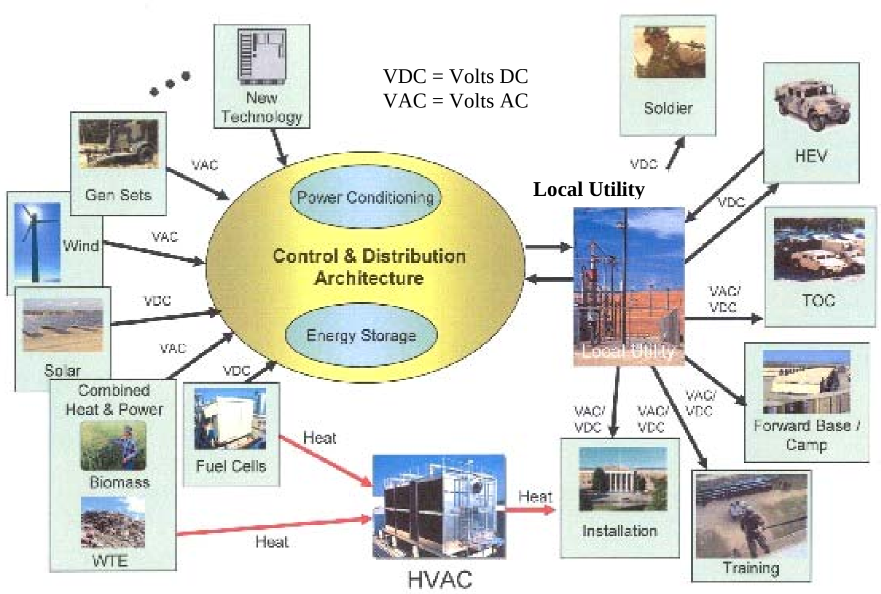

Figure 1. Army power architecture: home station-to-foxhole.

This type of control and power distribution architecture provides for warfighting power and energy home station-to-foxhole. On the upper right side of the figure are: soldier power, Hybrid Electric Vehicles (HEV), Tactical Operations Centers (TOC), and Forward Camps. Army installation operations and training stationary power needs are illustrated in the lower right corner. Various types of distributed power delivery are illustrated on the left side and use of byproduct heat is illustrated along the bottom of the figure. There is a box labeled “new technology” to illustrate the powerful “plug and play” nature of this intelligent power delivery architecture for power sources not yet even developed. Utility company power delivery (right middle of figure) is shown for stateside installations or forward operations where such utility power is available and affordable. It is an integral aspect of the power delivery suite. The heart of the vision is in the Control and Distribution Architecture shown in the oval in the middle of the figure. There is no control architecture capability today to provide for autonomous plug and play of a variety of power delivery and storage devices in harmony with complex demand-side energy needs.

Conference participants expressed a consensus desire for a unifying vision of power and energy delivery for Army installations. Hartranft presented a candidate vision centering on this new power delivery architecture (shown in Figure 1) to ensure warfighting mission readiness while also ensuring

that installation energy is available, affordable, sustainable, and secure. Power delivery for the 21st century must assure mission accomplishment in the face of global war on terrorism and asymmetric enemy threats. Hartranft's presentation offered the following installation power delivery attributes (EPRI 2003) for Army to aspire to and embrace in its vision of energy security and independence:

- Integrated, self-healing, electronically-controlled system of extreme resiliency and responsiveness.
- Fully capable of responding in real-time to the billions of decisions made by soldiers and their increasingly sophisticated microprocessor agents.
- Electricity and information infrastructure that enables the next wave of technological advances to flourish.
- System will always be on and "alive," interconnected and interactive, and merged with communications in a complex network of real-time information and power exchange.
- The "self-healing" system will sense disturbances and counteract them, or reconfigure the flow of power to cordon off a disturbance before it propagates.
- Smart enough to seamlessly integrate traditional central power generation with an array of locally installed, distributed energy resources into an installation network.
- Will be constantly self-monitoring and self-correcting to maintain the flow of secure, digital grade quality, and high reliability and availability power.

Sandia National Lab's conference presentation showed the steps they are making toward such a networked power concept and TARDEC presented actions they are taking in pursuing a mobile microgrid capability at Selfridge ANG. So, here are take away thoughts of the importance of Army adopting a unifying energy security and independence performance vision and associated performance requirements that encompass some or all of the aforementioned capabilities:

- Enables policy makers to shape strategy to achieve vision
- Enables technologists to assess technical maturity for solutions and to craft proposals for compelling DoD military capabilities

- Provides foundation for establishing proponency at highest levels for seeking funding to implement
- Facilitates clear collaborations with other government, industry, and academic agencies for common advancements.

There was discussion during the conference evening dinner presentations about the possibility for an installation energy security Battle Lab akin to the Army's traditional combat battle lab functions. Here are some thoughts on what this might this look like and do for Army and how to orchestrate it:

- Steering Group to oversee; Working Group to staff and scrub candidate technologies and policies
- Interface with Army Tech Standards Group
- Contractor site for demonstrating emerging capabilities ... subsidized by contractors
- Interface for FOB considerations
- War-gaming platform for policy and procedure evaluations.

3.3 Grid reliability and distributed power generation delivery (Day 2, Session III)

3.3.1 Duke Power Presentation on Transmission

Duke Power is the electric utility serving 2.2 million customers in North and South Carolina. They have 13,000 miles of transmission lines and 96,000 miles of distribution lines in the Carolinas. Duke Power pays most attention to its transmission lines as major power feeders into and out of their domain. Our Army installations are at the end of "distribution" lines. Duke Power stated that distribution lines are less monitored and ... loss of a single distribution element leads to power outage without contingency for backup power. Hence our Army installations are vulnerable to distribution element failures and Duke Power has no contingency for individual distribution elements. Mr. Bell suggested that customers should develop their own power contingency plans.

3.3.2 DOE Speaker on Electricity Delivery and Energy Reliability

Ms. Smith emphasized the importance of combined heat and power (CHP) in distributed generation. Such an integrated local system utilizes electricity and heat generated from the same energy source. Combined heat and

power uses all technologies and fuels. On-site electric generation reduces utility grid congestion and avoids distribution costs plus it reduces emissions by virtue of much higher net energy efficiency by producing both electricity and heat from the same fuel. She sees the following critical market issues in need of resolution for increased penetration of local CHP:

- Tariff Design
  - Standby / Back-up Power Rates
  - Exit fees
  - Tariff structures
- Interconnection requirements
- Environmental permitting
- Identifying full economic value
- Market uncertainty.

Ms. Smith assessed the overall U.S. energy infrastructure and showed the available power capacity margin decreasing from 16 percent in 2006 to 7 percent by 2015 as U.S. power demand continues its growth. She showed the U.S. electric reliability decreasing with associated increased frequency of power outages. She summarized that maintaining reliable power supplies is a growing concern as a result of:

- Increased incidences of grid outages
- More intense and more frequent weather events
- Susceptibility to terrorism and other man-made disturbances
- Consequences for health and safety, and for business continuity.

She sees CHP enhancing local reliability by:

- Already being up and running at time of outage
- Providing seamless load support during momentary interruptions
- Maintaining critical building or life support loads during sustained interruptions
- Providing a positive return on investment in assets
- Stabilizing local grid on “design days.”

When asked about traditional diesel generators providing needed back up power, Ms. Smith offered the following sobering anecdotes from the 2003 Northeast U.S. blackout:

- “Half of New York City’s 58 hospitals suffered backup power failures during the blackout” – *New York Times, 8/16/2003*

- "Lack of backup power allowed 145 million gallons of raw sewage to be released from a Manhattan pumping station" – *Times Union, 8/29/2003*
- "Jail's emergency generator fails during blackout, again…" – *Times Union, 8/16/2003*
- "Generator failures at a Verizon office …caused communications gaps for 911 dispatchers…" – *Daily*

She offered the following comparative experiences of two Gulf Coast hospitals from the 2005 Gulf Coast hurricanes (Table 2). One hospital had a CHP system; the other had only traditional backup generators. The CHP-powered hospital stayed fully powered; the other hospital not only got shut down, but had lasting difficulties due to extended time without power due to humidity, etc. damage while without power.

Table 2. Experiences of two Gulf Coast hospitals during the 2005 hurricanes.

Mississippi Baptist Medical Center (CHP System)	Memorial Herman Baptist Hospital (Backup Generators)
• Remained open and treated a high volume of patients • Provided clothing, food, and housing for displaced patients during the first night of the disaster • Opened a round-the-clock day care to allow employees to focus on patient care • 52 hrs of 100% operation on CHP • Only Hospital in the Jackson Metro Area to be Nearly 100% Operational	• Back up generators started, but could neither power the chillers nor maintain power due to length of outage. • Provided no medical services during or after the storm • Remained closed for seven days due to lack of power and water • Lost operating revenues and suffered damages of over $30M primarily from loss of HVAC system. Humidity infiltration resulted in extensive damage to floors, ceiling tiles, medical supplies, and equipment.

3.3.3 University of Wisconsin Speaker on Microgrids

Professor Lasseter presented the audience the initiatives he is pursuing on microgrids for local distribution. He heads the microgrid initiative of the Consortium for Electric Reliability Technology Solutions (CERTS). He stated that the CERTS microgrid vision today is a cluster of sources and loads that can operate both grid-connected or islanded, enables the uses of waste heat and ensures high local reliability to the loads. A future CERTS microgrid vision is of a system for local reliability and flexibility, that increases robustness of Transmission and Distribution system, and that promotes the use of demand response, CHP, and use of renewable intermit-

tent resources. He and the CERTS see the following as future microgrid objectives:

- Power from grid is constant 24/7.
- Storage is charged during low load periods.
- Generation is run at optimum level during high loads.
- Storage follows load and provides fast power balance during islanding.
- Thus the microgrid vision is to be always powered via a combination of traditional utility power augmented with local distributed generation with integral storage for intermittent generation from renewables such as wind or solar power.

3.4 Emerging Energy, Distribution, and Storage Technologies That Contribute to Energy Security/Independence (Day 2, Session IV)

The session opened with a broad overview of the energy issues confronting Army installations. The clear themes were the need to identify sources of fuel closer to installations and to be less reliant on the fragile, privately held energy infrastructure. The speakers provided more detailed analysis on the potential and future in solar, biomass, and combined heat and power applications.

3.4.1 Energy Policy and Critical Loads for Army Installations

Dr. Massie presented average battlefield fuel consumption on a per-soldier basis. Battlefield fuel consumption per soldier is growing at a rapid rate. Currently, the average soldier requires approximately 25 gallons of fuel per day. By 2020, the estimates range between 30 (best case) to 50 (worst case).

Awareness of this is not new. OSD guidance stretches back to as early as 1986 with four updates since with the most recent in 2005. Most of this is rhetorical, however.

The Army has received little detailed guidance as how to plan for its security position. For example, there has been no guidance on what constitutes “critical assets” or any real financial support for addressing energy security issues at the installation level.

Massie recommends a six-step vulnerability assessment guide that begins with on-base assessment, runs through off-post issues, identifies consequences of disruptions, and finishes with implementation of corrective measures.

A major recommendation is to pay more careful attention to local fuel source acquisition that can be relied upon when external grid support goes down. This would include attention to microgrids, distributed generators, and alternative fuel supplies.

3.4.2 Energy Support Analysis of DOD Missions

Systematic attention to Army Installation Energy Security is not new. There have been at least three previous efforts since 1993 to address the issue. These are the 1993 Renewables and Energy Efficiency Planning (REEP), the 2002 Army Installation Energy Security Planning (AIESP) and the ongoing Western Hemisphere Information Exchange (WHIX).

As part of the (WHIX), a project was undertaken in 2006 called the Sustain the Mission Project (SMP) that examined the full cost of providing energy and water to sustain Army training and operations. The complete cost of providing JP-8 fuel was $13.68/gal.

Moving toward a more local supply of renewable fuels would decrease the transportation costs of fuels and would add to local economic development opportunities.

3.4.3 New and Emerging Developments in Solar Energy

There are many new advances being made in solar energy applications. He focused on three – photocatalytic oxidation for environmental cleanup, new concepts in thermal power, and new concepts in direct energy conversion.

Direct applications for environmental cleanup are found in groundwater cleanup, industrial wastewater, and contaminated air emissions. Case studies are provided.

In the solar thermal arena, new hybridization approaches are being proposed to bring capital costs down. And in the electrical generation arena,

new breakthroughs in nanotechnologies are offering new and less expensive solar conversion opportunities.

3.4.4 Opportunity Fuels: Renewable and Bio-Energy Potential

The conventional means for generating electricity and providing transportation fuels are very inefficient. Combined heat and power (CHP) applications increase efficiencies by factors of 3 to 5 in magnitude.

Conventional energy prices are increasing while renewable costs are declining across the board.

While solar and wind are potential applications for Army installations, their costs and reliability are currently not the optimum solution. Biomass usage is viable in areas with large forest products such as the Carolinas. From woody biomass to landfill gas to energy crops, eastern NC has a tremendous potential to provide the bulk of the energy needs for eastern NC Army installations.

3.4.5 DG/CHP for Energy Security

There are currently active collaborations among the Federal energy labs, private vendors and Army installations in the DG/CHP field.

At Fort Bragg, the CHP demonstration has resulted in a savings of $1.8 million in annual energy costs.

CHP is a triple win: cleaner environment, power security, and greater reliability.

4 Summary and Recommendations

4.1 Summary

Present Army installation secure power contingencies are dependent on critical facility dedicated power sources. Some believe that this will improve the reliability of installation facilities power. However, this does not provide installation distribution redundancy to facilities. As a consequence, only pre-defined critical facilities will be configured with dedicated power sources even though GWOT asymmetries and dynamics may cause other facilities to be critical “tomorrow.” Also, the probability that power will be available to those few facilities with dedicated backup power sources is completely dependent on the individual standby generator. These generators require frequent maintenance and regular operations and maintenance (O&M) schedules in order to approach rated reliability. The probability that a stand-alone engine generator is available at the moment of need is unrelated to the level of criticality of the facility (i.e., electrical energy security is the same for all facilities with a single backup generator). Other less critical facilities depend solely on utility grid power. This isolated architecture cannot meet security needs, which is one of the five goals of the 2005 Army Energy Strategy for Installations.

Many of the conference speakers spoke highly of the economic and security benefits of distributed generation devices for power and thermal energy. The U.S. Army Energy Strategy for Installations also includes goals to increase the use of renewable energy while decreasing dependence on fossil fuels. Options being considered include the increased use of photovoltaics (PV), wind energy, biomass, and fuel cells using a distributed generation approach. Should certain technical barriers be overcome, the micro grid approach promises to synergistically meet these goals while also achieving the energy security goal. ERDC-CERL investigated the control dynamics of adaptive and scalable power and energy systems for military microgrids and published their analysis and recommendations in ERDC-CERL TR-06-35 (Abdallah et al. 2006).

This microgrid power architecture initiative also provides DoD with a solution to one new and one emerging requirement. The January 2007 Executive Order 13423, *Strengthening Federal Environmental, Energy, and*

Transportation Management (2007) calls for at least half of the statutorily required renewable energy consumed by a Federal agency in a fiscal year to come from new renewable sources, and to the extent feasible, the agency should implement renewable energy generation projects on agency property for agency use. The emerging requirement is a part of draft recommendations by the Facilities Panel of the Defense Science Board Task Force on the Development of a New DoD Energy Strategy (2007). The recommendation says that, by 2025, all installations will be able to sustain critical mission capabilities for a minimum period of 6 months without any reliance on the off-post commercial power grids or fuel supplies. No such standard exists today; uninterrupted power generators for a few limited facilities like hospitals are currently designed to supply minimum power no longer than 3 to 5 days. The microgrid control architecture addresses both the new and the emerging requirement in an affordable, scalable, and adaptable way.

4.2 Recommendations

4.2.1 2nd Energy Security and Independence Conference

There should be a 2nd conference to continue to advance the state of DoD installation energy security and energy independence. Its specific focus should be agreed upon by ACSIM and IMCOM in partnership with ERDC-CERL. As to timing of a 2nd conference, it would be wise to have it just before an upcoming engineering professional society meeting such as the Institute of Electrical and Electronic Engineers (IEEE). This would increase the likelihood of participation of IEEE technical experts at little added cost. This would also enable Army participants to stay beyond the Army Power Conference for a modest cost to benefit from the already-planned IEEE technical forums and learn more of emerging power technologies.

4.2.2 Energy Security Battle Lab

The Fort Bragg DPW brought up the idea of establishing an energy security “Battle Lab” at an active Army installation. This warrants further consideration. Some possible Energy Security Battle Lab objectives and considerations include:

- Could include energy security war gaming
- Conducting disruptive analyses on energy security systems

- Partners: Army installation, USACE, DCIP, Navy Dahlgren, DOE
- Policy, technology demonstration site, research and development (R&D) needs

4.2.3 Innovative Financing Mechanisms for Energy Security Improvements

The conference participants recognized the funding limitations for technologies solely for energy security when the installations are faced with ever growing Operations and Maintenance costs for utilities. Thus, attendees explored the integration of security-related characteristics with funded energy efficiency projects. The following are considered to be DoD energy priorities and also to be suited to making energy security connections:

- Sustainability
- EPAct 30 percent better than current ASHRAE standards
- 25 percent renewables by 2025
- Utilities privatization and modernization of non-privatized utilities
- Energy Conservation Investment Program (ECIP)
- More capable warfighting through reduced fuel burden
- Stability, security, transition, reconstruction (SSTR).

The recommendation therefore is for Army leadership to be receptive to inclusion of energy security characteristics in proposals for the above initiatives.

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Executive Order 13423 (January 26, 2007). *Strengthening Federal Environment, Energy, and Transportation Management.*

Draft Recommendations (February, 2007). *The Facilities Panel of the Defense Science Board Task Force on the Development of a new DoD Energy Strategy.*

Appendix: Conference Presentations

Conference on Army Installation Energy Security and Independence

Agenda for 12 December 2006 - Session I

Army Energy Security for Installations – Moderator: Jim Paton

What are the Current Policies for Energy Security/Independence?
What are the Issues Facing Army Installations?

08:45-09:30	**Sustain the Mission – Secure the Future**	Richard Murphy, Dept. of the Army, HQ
09:30-09:50	**Impact of Energy Infrastructure Disruptions on Army Operations**	Joe Dickman, Booz Allen Hamilton
09:50-10:10	**Energy Security in the Army Energy and Water Campaign Plan for Installations**	Jim Paton, ACSIM-HQ Energy Security Manager
09:50-10:10	**Energy Security: An IMCOM Perspective**	Paul Volkman, IMCOM-HQ
10:45-11:15	**Ft Bragg: Securing the Nation's Power Projection Platform**	COL Gregory Bean, DPW Ft Bragg, NC
11:15-11:40	**A Billion Dollar Investment to Construct and Renovate Troop Barracks**	Dr. Peter Rojeski, NCA&T
08:30-08:45	Welcome	Dr. Janice Brewington, NCA&T Provost
12:00-13:30	**Luncheon Speaker: Sustainable and Secure Energy Strategies**	Larry Shirley, NC State University

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Conference on Army Installation Energy Security and Independence

Agenda for 12 December 2006 - Session II

Army Energy Security for Installations – Moderator: Roch Ducey

What are the Future Visions for Army Installation Energy Security and Independence?

13:30-13:55	**Energy Surety Microgrids for Military Applications**	Abbas Akhil, Sandia National Labs
13:55-14:20	**Army Energy Security: A Vision for the Future**	Dr. Tom Hartranft, ERDC-CERL
14:20-14:45	**Advanced Energy Initiative – 21st Century Based**	Harold Sanborn, U.S. Army TARDEC
14:45-15:00	Break	
15:00-15:25	**Emergency Preparedness and Disaster Recovery**	Prof. John Pine, LSU
15:25-15:50	**Economic Diversification of Energy Resources**	Bill Stein, Ft Huachuca, AZ
15:50-16:30	Panel Discussions	Roch Ducey, ERDC-CERL
16:30-17:00	Wrap-Up and Take-Away Summary	Dr. Tom Hartranft, ERDC-CERL

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Conference on Army Installation Energy Security and Independence

Agenda for 13 December 2006 - Session III

Grid Reliability and Distributed Power Generation Delivery – Moderator: Keith McAllister

08:20-08:30	Welcome	Dr. L. Hackley, NCA&T Chancellor
08:30-08:45	**Take-Away Summary of Day-1 Discussions**	Dr. Tom Hartranft, ERDC-CERL
08:45-09:10	**Grid Reliability**	Edgar Bell, Duke Energy
09:10-09:35	**Distributed Generation for Reliability and Security**	Merrill Smith, U.S. Dept. of Energy
09:35-10:00	**Distributed Generation Benefits, Market Drivers and Value Proposition for Reliability and Security**	Paul Bautista, Discovery Insights, LLC
10:00-10:15	Break	
10:15-10:40	**Advanced Mobile Microgrids Power System and Mobile Waste to Energy System**	Dave McLean, Next Energy
10:40-11:05	**Microgrids on Distribution Scale**	Dr. Bob Lasseter, Univ. of Wisconsin
11:05-11:30	**Energy Security Analysis in Support of DoD Missions**	Steve Siegel, Energy and Security Group
11:30-12:00	Panel Discussions	Keith McAllister, NC State University
12:00-13:00	Luncheon Speaker	Dr. Katie Dorsett, NC State Senator

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Conference on Army Installation Energy Security and Independence

Agenda for 13 December 2006 - Session IV

Army Energy Security for Installations – Moderator: Dr. Dennis Grady

What are the Future Visions for Army Installation Energy Security and Independence?

13:00-13:25	**Energy Policy and Critical Loads for Army Installations**	Dr. Darrell Massie, Intelligent Power & Energy Research Corp.
13:25-13:50	**New and Emerging Development in Solar Energy**	Dr. Yogi Goswami, University of South Florida
13:50-14:15	**Renewable and Bio-Energy**	Dr. Alex Hobbs, NC State University
13:50-14:15	**The Lignocelluloses Bio-Refinery - Realty Hype or Something In-Between?**	Dr. Steve Kelly, NC State University
14:15-14:55	Break	
14:55-15:15	**Conversion of Woody Biomass to Synthesis Gas Using Cross-Draft Gasification Technology**	Forpu Njkam, NCA&T State Univ.
15:15-15:40	**DG/CHP for Energy Security**	Patti Garland, Oak Ridge Natl. Labs
15:40-16:25	Panel Discussions	Dr. Dennis Grady, Appalachian St.
16:25-17:00	Wrap-Up and Take-Away Summary	Dr. Dennis Grady, Appalachian St.

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14. ABSTRACT

This report is about energy security … for mission accomplishment. Is energy security assured by backup generator sets dedicated to individual buildings that are pre-identified as critical assets – with fuel for 3-5 days? Suppose a utility power grid outage occurs. Today it is impossible to locally wheel power from dispersed individual onsite fossil-fueled or renewable power sources to facilities or other power loads … anywhere at any time. Each power source is stranded; powering only one load. Relocating generator sets and engineering their electrical connections to other power loads are not speedy or trivial tasks. There are many mission aspects that go unpowered in a blackout because Army cannot afford backup generator sets for every building, training range, sewer treatment plant, warehouse, motor pool, etc. Even if everything has dedicated backup generators, experience shows that 50 percent will not operate right anyway … and they will run out of gas after 3-5 days. Mission priorities are dynamic; power outages are unpredictable. Commanders must have the ability to wheel dispersed and finite on-installation power anywhere at anytime and to allocate stored fuels for extended outages. A new vision of energy security is needed for the asymmetrical threats and dynamics of the GWOT era.

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